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ABSTRACT

This publication is one in a series of 12 giving the recommendations that were made for a broad and balanced education program in science for young people. Section one of this guide discusses gender-related issues raised by examining the interests, attitudes, aspirations and behavior that young people bring with them into science classes. Section two considers some of the attitudes and experiences which are present in the environment of young children and help to shape their image of the world. Section three considers daily interactions with students, identifies implications, and includes two checklists for teachers. Section four looks at sex-linked choices currently made by students. Section five looks at the future and the changes required if the goal of equal opportunities in science education are to be realized. An introduction, reading list, and references are provided. (RT)

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SECONDARY SCIENCE CURRICULUM REVIEW

SSCR

BETTER SCIENCE:

For both girls and boys

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Curriculum Guides

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SECONDARY SCIENCE CURRICULUM REVIEW

SSCR

BETTER SCIENCE:

For both girls and boys

Curriculum Guide 6

Compiled by Christine Ditchfield and Linda Scott

Heinemann Educational Books/Association for Science Education
for the School Curriculum Development Committee

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Christine Ditchfield and Linda Scott (SSCR Coordinator for Gloucestershire LEA)

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Foreword

This is the sixth in a collection of twelve Curriculum Guides from the Secondary Science Curriculum Review, published jointly by Heinemann Educational Books and the Association for Science Education.

A *Directory of Resources* and a book, *Better Science: Making it happen*, which tries to set the Review's recommendations in the context of the whole school, will appear at the same time as the Guides. These will, when taken with earlier and forthcoming SSCR publications, including those from local groups, constitute the recommendations which the Review is making towards a broad and balanced science education for all the young people in our schools. The series title, 'Better Science' is thus both apposite and self-explanatory. It is hoped that the current phase of the Review (1986–89) will achieve successful imple-mentation of the recommendations.

But what is the status of these new publications apart from reflecting the formal approval and support of our major sponsors, the School Curriculum Development Committee and the Association for Science Education? From what sources have the recommendations within them emanated? Those readers unfamiliar with the history of the SSCR will find it explained within the Guides; but most will be aware that it set out as a project which tried fully to involve the practising teacher in the development of solutions to the problem of science for all. Thus, although the Guides have been compiled principally by the Central Team of the Review, they draw on the work of thousands of teachers in working groups over the past four years. Although the work of many of the groups is referred to in the Guides, it is not possible to refer to it all. In the *Directory of Resources* readers will find details of what many of these groups have produced. The writing of these Guides, however, would not have been possible without the groups' existence and the Review Central Team hopes that the content of the Guides truly reflects their work. Thus the pronoun 'we', used within them, often reflects the view, gleaned over five years of consultation, of the practising teachers involved with the Review. On other occasions it can represent the views of the SSCR as constituted by the Central Team and Steering Committee and it is hoped that particular usage will be apparent from the context.

Jeff Kirkham
Mick Michell
Jeff Thompson
Dick West
(SSCR Curriculum Guide Editors)

Introduction

'Science for all' is the cry . . . and equal opportunities is the message. Equal opportunities for all youngsters to experience a broad science education from 5 to 16, no matter what their gender, ethnic origin or class. Most people would agree that this is a commendable aim, but it is far from being realised in practice as many recent reports, notably those from the Assessment of Performance Unit (APU), have demonstrated (**0.1**).

Many of the SSCR resource documents examine ways of improving science provision for *all* youngsters. This publication focuses on ways in which science teachers can work towards:

> **providing equal opportunities for students within a broad balanced science education, which does not discriminate against them because of their gender.**

The SSCR proposals for a scientific education which is broad and balanced are well documented (**0.2**). In recent years much of the concern for curriculum imbalance with respect to gender has centred on the low numbers of girls studying the physical sciences. Indeed, there are many valuable lessons which projects like GIST (Girls Into Science and Technology) have to teach us.

Although this report will lay heavy emphasis on improving the lot of girls with respect to their science education, we are aware that it is not just girls who are disadvantaged. Many boys also have an unbalanced curriculum so our discussions will be with respect to establishing balance and creating a school science which is 'gender-neutral'.

In recent years there have been three boys for every girl studying for physics O level and four boys for every girl in the case of CSE (**0.3**). A more detailed look at the statistics shows that there are three times as many girls studying biology for O level as studying chemistry or physics and one and a half times as many boys studying physics for O level as studying chemistry or biology. Such statistics reflect the situation in schools after options have been chosen, but the disaffection which is implied by this polarisation must have origins in earlier schooling.

The situation described by the breakdown of the examination entries is familiar to many of us, and most teachers have their own anecdotes which explain or challenge the statistics. As writers of this report, we are presented with the difficult task of identifying the variables which create this imbalance and of presenting suggestions about improving the situation in the future.

At grass roots level, there are schools and individual teachers whose students' performances and interests run contrary to the national trends. That is, they have higher than average numbers of youngsters opting in to science courses, and less discrepancies between the girls and boys in their selection of topics and subjects within science. We have tried to draw on some of their experiences in preparing this report.

This Curriculum Guide assumes that, in future, students will be following courses which provide balanced science until they are 16. By this we mean a curriculum which draws its content from biology, physics and chemistry together with other less familiar school science subjects such as earth science and astronomy. At the same time, such a curriculum will emphasise the skills and processes required to engage in science activity. Therefore we are particularly interested in the *gender-related influences* which will affect the learning outcomes of this education. We begin by presenting (Fig. 1) four major influences on the learning outcomes of a secondary school student. (These influences are not, of course, independent variables – each interacts with all of the others resulting in a complex web of relationships.)

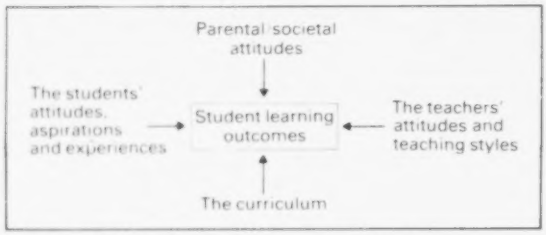


Fig. 1 Major influences on learning outcomes

Better Science: Approaches to teaching and learning focuses on the desirable learning outcomes of science education and this does not require repetition here. However it is our intention to examine the ways in which we as science teachers can work towards improved learning outcomes for *both* boys and girls. To do this, we consider, in separate sections, the gender related influences which may hinder a youngster's progress in science. In ordering this Curriculum Guide in this way, it is not our intention to lose sight of the inter-relationships and, indeed, the interaction of the different influences. The implications for practice forms the body of each section.

In producing this Curriculum Guide, we have attempted to summarise some of the research data (much of it from SSCR groups) and have drawn heavily on existing publications. The early sections are therefore devoted to restating the problem in order to provide the rationale for the strategies for change developed by SSCR groups

and others which are proposed in the final section.

Section 1 'Student Perceptions' includes extracts from recent research findings concerning gender and science education. In particular it discusses issues raised by examining the interests, attitudes, aspirations and behaviour which youngsters bring with them into science lessons.

Society is probably the most powerful influence on student learning outcomes. By the time that youngsters enter secondary schooling they are displaying marked sex-stereotyped views and behaviour. Section 2 'The Influence of Society' considers some of the attitudes and experiences which are present in the environment of young children and which are influential in shaping their image of the world about them.

Section 3 'The Teacher Influence' considers how our day-to-day interactions with students may influence their views about the appropriateness of science for both boys and girls. It identifies implications which need to be addressed both within and outside the classroom, and includes two useful checklists for teachers to use when examining their own practice.

Section 4 'Ways Forward for the Science Department' first takes a quick look at the sex-linked choices which students currently make. We then go on to consider the characteristics of a future science curriculum which might appeal equally to both sexes and describe curriculum development work which has been undertaken by practising teachers to try to overcome the problems described in the earlier sections.

In the final section 'Conclusions' we look to the future and the changes which will be required if the goal of equal opportunities in science education is to be realised.

At the end of each part of every section, where it is appropriate, we present the implications for teachers. These comprise a cummulative list of recommendations. (In Section 4 they become 'ways forward'.)

SECTION ONE

Student perceptions

Introduction

By the age of eleven, many youngsters demonstrate sex-stereotyped behaviour and attitudes. What are the effects of this on individual youngsters responses to science, and how can we take into account the different characteristics of girls and boys without falling into sex-stereotyping ourselves?

In attempting to look at gender-related differences, we face a dilemma. By separating youngsters into two groups with enormous diversity within the groups, we are in danger of forgetting that we are talking about individuals. Not only that, but if we then start making generalisations about each group – 'boys are more demanding of teachers attention' . . . 'girls lack confidence in themselves' etc. – we then fall into our own version of stereotyping.

In writing about boys and girls we will inevitably polarise the gender-related characteristics. We do not feel that this is a problem so long as the reader bears in mind that we are talking of tendencies rather than suggesting that, for example, all girls have the same interests or all boys behave in particular ways. However, since we are talking about adolescent youngsters, perhaps it is true to say that they exhibit more sex-stereotyped characteristics at this age than at any other time in their lives.

Most teachers would agree that good teaching starts with the learner, their interests and experiences. Although we may regret the limitations which youngsters place on themselves because of their gender, we would be foolish to ignore that they do it. Therefore this section summarises current research findings about the gender-related differences between youngsters with respect to their interests, aptitudes, learning styles, classroom behaviour, their view of themselves and their future aspirations. We hope that a closer look at these influences will provide the reader with the rationale for the strategies for change outlined in Section 4.

Differences in aptitides and experience

A new report from the science monitoring group of the Assessment of Performance Unit (APU) (**0.3**) examines some of the differences in performance of girls and boys. The six sub-categories, which were assessed by the administration of sufficiently large numbers of questions, were as follows:

Using graphs, tables and charts
Using measuring instruments
Making and interpreting observations
Interpreting presented information
Planning parts of investigations
Applying science concepts.

The surveys at ages 11 and 13 revealed that the performance of girls and boys do not differ significantly in five of these categories. The only *statistically significant difference* was in the 'application of physics concepts' where boys consistently performed better than the girls and

Activity	% pupils boys	girls
Make models from a kit (Airfix)	42	6
Play pool, billiards or snooker	59	30
Play with electric toy sets	45	16
Create models using Lego, etc.	50	23
Take things apart to see inside	38	18
Go fishing or pond dipping	30	13
Watch birds	30	27
Sow seeds or grow plants	30	34
Look after small animals/pets	52	57
Collect/look at wild flowers	8	27
Weigh ingredients for cooking	29	60
Knit or sew	5	46

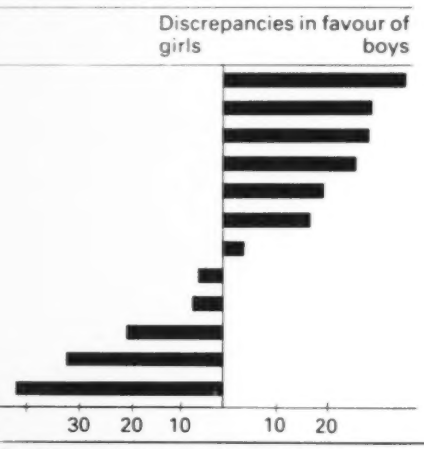


Fig. 2 *Differences in the percentages of 11 year-old boys and girls reporting to have 'quite often' engaged in particular activities at home or otherwise out of school (From 1984 APU national survey data – approximately 6000 pupils were sampled,* **0.3**)

even this difference was small. Boys' superiority in the application of physics concepts were consistent across all the physical science concepts and topics in the assessment but it was particularly marked in the case of electricity at all ages.

A closer look at the test scores for 'using measuring instruments' reveals that although there is no general weakness on the part of girls in this area, there were differences with respect to the use of *particular* measuring instruments. Ability to use stop-clocks, hand lenses, microscopes, force meters, ammeters and voltmeters were different for girls and boys, in favour of the boys.

Thus it would seem that the relative underachievement of girls in the use of physics concepts and skills related to work in physics is apparent from quite an early age. Since their experience of science education at the ages of 11 and 13 is very similar, it is likely that it is their everyday, 'out of school' experiences which are influential. This is borne out in the APU survey data showing the difference in the percentage of 11-year-old boys and girls who had 'quite often' engaged in particular activities at home or otherwise out-of-school (Fig. 2).

In particular, these results suggest that boys have a much greater opportunity of accumulating a working knowledge of mechanics and of gaining an early familiarity with electricity (both topics in school physics in which girls' performances are weaker than boys'). Similarly, differences emerge in the reported use of measuring instruments.

The very instruments with which boys claim to be more familiar than girls are the ones for which significant performance discrepancies in favour of boys have emerged in APU tests (Fig. 3).

Measuring instrument	% 11-year-olds boys	girls	Discrepancies in favour of girls	boys
Compass	69	48		
Microscope	49	34		
Stopwatch/clock	66	52		
Spring balance	28	20		
Hand lens	70	59		
Metre stick	22	16		
Thermometer	53	49		
Weighing scales	75	81		

Fig. 3 Differences in the percentages of young boys and girls reporting the use of particular measuring instruments at home or otherwise out of school (From the 1984 APU national survey, **0.3**)

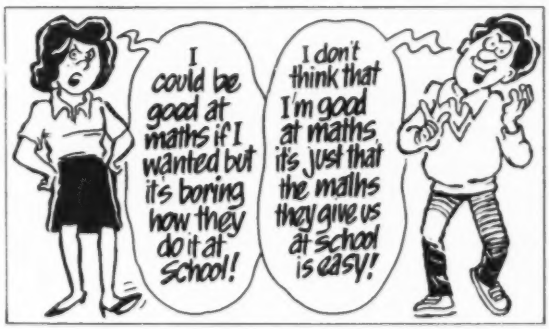
These discrepancies go some way to explaining the different scores described previously. It would seem that the 'tinkering' activities which boys are more likely to experience are advantageous in developing the skills and concepts related to education in the physical sciences as they are currently presented. The 'homemaking' activities which are more likely to be the experience of girls will develop a great range of skills, but they are not necessarily those which will give them a head start in science education. However, we note that although girls may be disadvantaged with regards one aspect of the curriculum, in terms of overall educational experience, the boys too are greatly disadvantaged because of their lack of experience of activities related to being able to look after themselves and others!

It is worth remembering that the data we have presented so far refers to average scores from the large APU samples. As we warned at the beginning, we must beware that we don't forget the individuals themselves. In the case of 'application of physics concepts' there will be many girls who score better than most boys. However, it would seem that because of differences in early experiences, it is the girls who are more likely to be at a disadvantage with regard to the skills and concepts in science which are currently viewed as important.

Implications

- More attention needs to be given to compensating *all* young people for their lack of early, varied, practical experience. This needs to be done at all stages of education.
- Diagnostic assessment techniques are required to help *all* youngsters discover their strengths and weaknesses.

Self-confidence and self-esteem


I could be good at maths if I wanted but it's boring how they do it at school!
I don't think that I'm good at maths, it's just that the maths they give us at school is easy!

What do these statements suggest about the youngsters' views of themselves? What effect will such views have on their performance in maths? Self-confidence and self-esteem are major influences on how a youngster learns and can either encourage or hinder progress.

There are many definitions of the terms self-confidence and self-esteem. For the purposes of this report, they are defined as:

Self-confidence – the expection an individual has that they will be successful and will achieve.
Self-esteem – not necessarily linked to 'winning', but a level of self-acceptance, self-respect and feelings of self-worth.

Obviously the levels of self-esteem and self-confidence will affect the way an individual presents her/himself and could be an inhibitor to progress.

Consider this A level physics lesson which suggested gender differences to the class teacher, who recalls:

> *The class were working individually on a standard experiment involving the construction of an electrical circuit. Within minutes of each other, a boy and girl realised that their circuits were not responding in the expected way. Each turned to me to sort out their problems.*
>
> Neil *pronounced 'It's not working' – a statement that he had tried, couldn't get the expected outcome, and had come to the conclusion that there was something wrong with the circuit or the apparatus provided – a valid summary of the circumstances. Once the fault had been identified (a poor connection) he returned to his task, quite unconcerned about the incident.*
>
> Amanda *on the other hand, explained apologetically 'I can't do it' – she had evidently checked the circuit herself and could not find the fault and so was upset by the incident in a different way to the boy. Once the fault was located for her, the accompanying statement 'it was only a poor connection' didn't comfort her, if anything it served to knock her confidence further by the suggestion that the fault was a simple one (and therefore by her argument, she should have been able to cope with it herself). She did return to the experiment, but with less enthusiasm than before the incident.'*

Was this merely a case in which the boy concerned had more experience of circuits and was prepared to accept that faulty connections are not always easy to locate, or was the whole incident an illustration of a difference in the self concept of the pupils concerned? The teacher continues:

> *Once alerted to the difference in attitudes displayed in this incident, I began to take note of the frequency of similar occasions, both with this class and amongst younger pupils. The observations have convinced me of the existence of a confidence barrier and this has influenced my teaching style in an attempt to help girls to overcome this disadvantage.*

This teacher isn't the only one to investigate such influences. Research in Australia, (**1.1**) has provided evidence that, during adolescence, the boys displayed higher levels of self-esteem than their female counterparts. One study (**1.2**) showed that these differences between the sexes increased progressively throughout adolescence.

Low self-esteem is not confined to girls (see **Better Science: For young people with special educational needs**). However it does appear to be a major obstacle for many of them, since it may result in their failure to make the most of the educational opportunities available. Research reveals that in secondary schools, girls develop a self concept which includes under-estimation of their own academic abilities (**1.3**). The studies indicate that girls tend to rate themselves lower on academic subjects than boys and, importantly, girls' self-ratings are consistently lower than their measured abilities. Viewed alongside their opinions that 'physics is the most difficult science' (**1.4**) we can perhaps see why girls believe that it's not for them.

The extra self-confidence displayed by boys in science-related activities can be an asset, for example, when it enables them to accept help and then build on it (as in the classroom example quoted above) or when it allows them to work on their own initiative. This attitude difference between the sexes is not restricted to their performance in practical work as the following examples, recorded during the Girls Into Science and Technology (GIST) project (**1.4**), indicate:

> *When one class were asked what they thought of a test, the boys chorused 'easy' while the girls said rather plaintively that 'the electricity was horrible'. In fact, the boys and girls had done equally well on the test, so the difference in response was more indicative of attitude than achievement. Similarily, the boys' self-confidence is shown in the way in which they answer questions:*
>
> *. . . in class discussion round the front, the boys were falling over themselves to give the answer and the girls were sitting back . . . Boys know technical vocabulary . . . Boys give lots of examples of light bending, mostly wrong (for example with a magnet), but they don't care.*
>
> *Here the boys are actively participating in the lesson, the girls are passively listening (or not listening). There is a considerable element of bravado in the boys' use of technical terms that they don't really understand, but they don't mind taking the risk of being wrong.*

The display of self-confidence on the part of the boys in the examples above contributes positively to their learning experiences and it would be to the advantage of girls to develop similar attributes. They do so in some social circumstances and in a few areas of the curriculum – why not science?

Implications

- We need to consider whether our own expectations of youngsters' educational achievements are influenced by their gender.
- We need to give all youngsters positive encouragement and support, at the same time providing them with sufficiently challenging activities. This is perhaps more necessary for girls than boys.
- We need to monitor the messages, which we are sending to our students via our teaching styles, and the contexts and contents of our lessons.
- Classroom strategies which allow girls (and some boys) to gain confidence are required. This may well mean changes to classroom organisation which would enable young people to explore science without fear of failure in front of their peers. For example, this might be through small group discussion work or, in some cases, by organising single-sex groupings (see Section 4).

Varied interests

When youngsters taking part in the GIST project were asked to indicate their interest in finding out more about certain science topics there was a marked sex-related difference (Box 1).

Girls			Boys		
Question	**%**		**Question**	**%**	
What food is good for you	73	(56)	How motor cars work	78	(30)
How children develop	70	(52)	Computers	73	(47)
Our eyes and how we see	65	(51)	Volcanoes and earthquakes.	71	(48)
What makes a rainbow appear	63	(47)	Stars and planets	71	(46)
How a record is made	63	(60)	How machines work	67	(26)
Germs and illnesses	60	(36)	How transistor radios work	66	(31)
Animals in the jungle	60	(60)	Nuclear power	64	(25)
Our ears and how we hear	58	(41)	Acids and chemicals	63	(56)
How our muscles work	58	(59)	How a record is made	60	(63)
Acids and chemicals	56	(63)	Animals in the jungle	60	(60)

These are 11-year-olds on entry to secondary school. Figures in brackets are percentages of the *other* sex answering 'I'd like to know more'.

Box 1 *Most popular science topics for 11-year-olds* **(1.4)**

Implications

- Science courses in the early years of secondary schools might be more interesting to both sexes if they were linked to the human body.
- We need to monitor the applications of science we use so that we ensure a balance between girls' and boys' interests and experiences.
- Learning environments are needed which enable youngsters to explore aspects of science which they may feel are 'inappropriate' because they are linked to the perceived interests of the opposite sex. For example girls may need considerable encouragement and support to investigate the workings of an engine whereas boys may find lessons relating to parentcraft rather uncomfortable.

Different aspirations

How youngsters view their future lives has an influence on their responses to the curriculum on offer. The Girls Education in Mathematics, Science and Technology (GEMSAT) team **(1.6)** found that at option time, 60 per cent of youngsters chose their options with particular careers in mind:

> *Pupils' choice about physics showed that career requirements/usefulness for a job were very important in their choice whilst for humanties, interest in the subject was the main reason for choice.*

The team collected information about possible careers intentions:

For girls: Hairdressing, nursery nurse/nanny and secretarial work were mentioned most frequently. Catering, primary teaching and banking were also popular responses.

For boys: Various forms of engineering and HM Forces were mentioned repeatedly. There was some regional variation with boys from rural catchment areas choosing farming.

Thus boys are far more likely to see their future careers in technical fields. For the girls, working with people seemed to be a primary concern. For all the careers mentioned above, science would be very useful, although this may not have been made clear to the youngsters. The link between physics and engineering is perhaps obvious but is this true for nursing or primary teaching? It is worth pausing for a moment to consider how often we relate science to the world of work. Physical science textbooks demonstrate the applications at work in industry or in the garage but is there as much emphasis on 'physics in action' in the caring contexts of hospitals and aiding the disabled? Given that one of the major motivations for choosing science might be related to use for future jobs, we would do well to bear this in mind when choosing examples of the

applications of science so that we ensure diversity.

Not only do we have a role to play in informing youngsters of the diverse careers which require a science qualification. We also have a responsibility to encourage them to consider their futures in terms of their interests and abilities rather than allowing them to limit their career options because of their perceptions of the sex-appropriateness of particular careers.

Implications

- Youngsters need to be made aware of the usefulness of science qualifications for a wide variety of careers.
- Science lessons need to incorporate a wider set of 'applications' of science so that it is seen in contexts related to people as well as industrial and mechanical contexts.
- Schools should create opportunities to challenge youngsters' preconceived notions of sex-appropriate careers.

Behaviour

October 5th 1985

Another frustrating double lesson with my O level group today. It's not as if it's the bottom set where I get some difficult behaviour problems to deal with. In fact on the surface all looks well, we get through the work and are well on target to finish the syllabus by February and I know that there will be good results, but there's something about the atmosphere that isn't quite right. I can't admit it at school but having so many girls in the group this time has divided the class into two camps. Not that the girls are any trouble. In fact that's the problem, they don't draw any attention to themselves at all .. well apart from Mandy who is the boistrous and over-confident type.

I only discovered half-way through the lesson that Julie's group weren't doing the practical work at all but copying lengthy notes out of the book and doing the Michelangelo bit on the diagrams. Their main protest is that Jamie's group always 'nick' their equipment and 'anyway sir we never get the right results like the ones in the book so we thought we'd just as well copy them'. Good job they won't be doing the new exam which has got practical assessment.

I caught them this time, they never come and tell me these things. So often I'm surrounded by lads wanting this and that or I'm telling off Nick James's crew for mishandling equipment or messing about that I don't get time with the quiet ones. I know that there are some youngsters who don't get much of my time, John Holly for one, so I try to get them all together near the end of the lesson to talk about what's gone on and where there have been problems but I still don't get to the ones I want. There's one lesson in the week just before lunch when sometimes Julie and Gita stay behind and help me sort out the equipment trays which are invariably left untidy. I get a chance for a chat then. Mind you, their attitude is a bit worrying. They appear to be very defeatist about carrying on with physics, say it's far too hard for the likes of them.

Fig. 4 *Extract from the (fictitious) diary of Adrian P, science teacher*

The extract in Fig. 4 emphasises the polarity of behaviour patterns which exist in some science classrooms. Of course, not all boys are thoughtless in stealing equipment from other groups nor are all girls quiet . . . but what about the youngsters who are? The GIST team documented many instances in which boys dominated the classroom activities while girls took second place with regard to access to equipment and to the teacher's time. One of the GIST team, Judith Whyte, describes some of the incidents observed during the project (**1.7**):

> *Boys wanted to show teacher their completed table of results . . . often pushed in on a demonstration to girls, twice taking the teacher away from that demonstration. When girls wanted help they waited till the teacher had finished whatever she was doing.*
>
> *At one point a boy donned the goggles that a girl had put down for a second . . . the teacher noticed this and reprimanded him. He gave the goggles back, assuming surprise that she had not finished.*
>
> *Rush for apparatus at start of practical – a crush of boys with a few girls, most girls followed later.*
>
> *The boys moved freely around the room, chatting to each other . . . The girls restricted themselves to their benches and the teacher's table.*

Alison Kelly (**1.8**) another GIST researcher, comments on these classroom interactions in the following way:

> *Boys act as though they have absolute priority over the resources of the laboratory, whether they be the apparatus, the teacher's attention, or just the physical space . . . These behaviours are commonplace – so commonplace that they are virtually invisible.*

These examples of classroom behaviour by boys and girls have been selected to illustrate a point. However there is a growing weight of evidence from classroom observations to support the claim that they are not isolated incidents nor restricted to particular 'types' of schools (**1.9**).

If youngsters grow up with the view (which many do, see Section 2) that scientists are men and that science is a masculine activity, it is hardly surprising that the boys behave as if the laboratory is their preserve and that the girls concur with this attitude.

The rather aggressive behaviour of the boys could be interpreted as an indication of their greater enthusiasm, but the fact remains that they are acting in a way which is both self-centred and anti-social and which is inhibiting for the girls. Over-confidence can even be a source of danger to the pupil himself – when it comes out as unauthorised behaviour such as unsanctioned use of apparatus 'to see what would happen'.

As Kelly points out, much of the less acceptable behaviour by boys is virtually invisible because it is accepted as normal boyish behaviour. We firmly believe that the boys are quite capable of more cooperative and social behaviour in mixed classes. In fact if this expectation is not made clear to them and they don't see the need for it, we are not addressing their social educational needs.

Implications

- In designing teaching strategies we need to include those which will help to encourage social skills.
- Students need to appreciate that being aware of the needs of others is an important attribute in practising science where teamwork is the order of the day.
- Stereotypic views about who practises science need to be challenged so that students see science as a *human* activity not a *male-only* activity.

Different learning styles

We would argue that learning styles are peculiar to an individual. However, we would wish to discount some of the mythology surrounding girls' preferred styles. One such myth is that girls do not like practical work and can't handle the enquiry method. In the 1979 HMI survey (**1.10**), the Inspectors pointed out that although girls were more tentative in their approach to laboratory work, they placed a high value on it. Indeed this has been borne out by our own small-scale research into areas of science work which girls enjoy. By far the most interesting and enjoyable work that girls refer to is practical work. Time and again, however, is the request from girls that they want a chance to test out their own ideas and sort things out for themselves. A questionnaire asking them for comments about how they would like science education to be improved elicited comments like:

I'd like more experiments you don't know the answer to.

I'd like more individual work where we can try and prove things for ourselves instead of following instructions.

In a study of different teaching styles in science (**1.11**) three categories were described:

1 The 'problem solvers' were teachers who by questioning challenged students to observe, speculate and solve problems;
2 The 'informers' were those who presented youngsters with information;
3 The 'enquirers' encouraged youngsters to carry out their own investigations.

The problem-solving style was more popular with boys while the enquiry method seemed to be most effective for maintaining the interest of girls in the physical sciences.

Implication

- More varied teaching approaches are required if we are to maintain the interests of all youngsters.

What can be done?

Teachers may feel that there is little that can be done in science lessons to counteract the influence of society on the development of a youngster's attitudes and skills. However there is evidence to show that the adoption of intervention strategies in the laboratory and classroom can help (**1.4, 1.5, 1.6, 1.12, 1.13**). Changing teaching styles, including more varied examples of the applications of science, providing training to make up for lack of relevant, early childhood experiences and challenging youngsters notions about their future careers can all contribute.

We acknowledge that a single department acting unilaterally cannot expect to overcome all the gender-related influences which inhibit girls and boys from achieving their full potential. Naturally the impact will be greater if the teachers are working within a school which has a strong commitment and policy on equal opportunities and even more so if such policies are apparent through the whole education service of an LEA from pre-school provision onwards.

SECTION TWO

The influence of society

Early childhood is a period of rapid intellectual growth when many skills are developed and attitudes formed. The child is like a sponge that soaks up all that the environment has to offer. It is a period when the child learns to see him/herself in relation to other children and to adults other than parents. The transition from home to school is every bit as difficult as the later one from school to working life, arguably more significant. For it is at primary school that a child's previous experiences, in the home or in pre-school groups, are either reinforced or broadened. And this is particularly true of the child's experience of male and female roles and how behaviour patterns and expectations are divided into those which are 'appropriate' for boys and those which are 'appropriate' for girls . . . One of the main functions of education is to broaden understanding of the world, to enrich the individual experience of the child with a knowledge of what goes on beyond his/her limited experience . . . If children learn at an early age that boys do different things from girls and that sex, rather than individual talent or interest of a person, determines their life pattern and choices, they are conditioned to seeing themselves in the same light.

(European Community Action Programme, *How to Implement Gender Equality*; **2.1**)

An SSCR working group in Kent conducted a survey among two groups of girls and boys. One group was made up of 11 and 12 year-olds in their first year of secondary school and the other group of pupils were still in their final year of junior school. The survey was designed to identify patterns of job allocations within the domestic environment of the youngsters, which might be responsible for influencing their views on the role of men and women (**2.2**). In part of the survey, the youngsters were asked to state who was most likely to perform certain common jobs at home. A summary of their answers is presented in Box 2.

Job	Female	Both	Male
Washing up	46	41	13
Weeding the garden	29	27	44
Changing nappies	73	27	0
Checking the oil in the car	3	5	92
Operating the washing machine	84	12	4
Rewiring a plug	4	11	85
Hoovering a carpet	68	21	11
Repainting a kitchen	14	30	56
Mending a dripping tap	3	2	95
Cooking a roast dinner	75	21	4

***Box 2** The responses of first-year secondary pupils to the question 'Who at home is most likely to do the following jobs?'. The results are expressed as percentages.*

Most of these questions relate to activities which are carried out in most households across the country (with acknowledgement that many people are not car owners, and others, through choice, or financial constraint, do not eat roast dinners). The answers collated in Kent are a good illustration of the points raised in the opening quotation of this section: that youngsters are exposed to stereotyped 'models' of female and male behaviour in the domestic environment.

It can be argued that neither sex has a natural monopoly on any of these activities. Our communities include a large number of single people of all ages and many one-parent families, where one person assumes responsibility for all these activities, irrespective of their sex. Within households, certain allocations of jobs, as described above, may exist and it is therefore inevitable that the children of the household become aware of it. It seems likely that the youngsters will adopt similar stereotyped attitudes and values – unless they are exposed to alternative influences. Further, we would argue that the adoption of such stereotyped views is restrictive to the learning experiences of the individual, and is not an adequate preparation for their future lives.

Influences during early childhood

We cannot discuss the effect of stereotyping on students of 12 years or more without taking into account the plethora of experiences which have exerted influences on them up to that point in their lives. School is only one contributory factor, other influences such as the youngsters' home environment, the community in which they live, and their exposure to advertising and the media all play important roles in shaping the self-image which they develop.

One example of the way in which very young children receive messages about the sort of behaviour which is 'expected' of them is in the presentation of toys. Those specifically designed for girls are predominantly connected with domestic activities (shopping bags, sewing or knitting kits, toy versions of domestic appliances) or are related to caring activities (baby dolls, clothes and accessories, nurses' outfits) whilst those aimed at boys are mainly mechanical or connected with war or fighting (imitation guns and knives, miniature armies and military equipment, toy cars, lorries and train sets).

Role models

The following quotation is from an account written by a junior school teacher who is explaining why he believes that it is important for more men to be actively involved with the care of young children. It is adapted from an EOC publication (**2.3**).

> *Children need a new model of what it means to be a man – of maleness. It will be someone who cooks meals and repairs the car, who changes nappies and lifts heavy objects, who gives emotional support when someone gets hurt and also enjoys a pint. Someone who can be both tough and gentle; physically strong and graceful; thinks clearly and decisively and also shows when he's scared or cries when he is sad.*

We would add that it is equally important that children see a new model of what it means to be a woman. Her role is one in which her intelligence, resourcefulness, and management skills are given credit, alongside her capacity to care, whether they are exhibited in a domestic situation or in an office or factory.

At the moment many girls suffer from a lack of commitment towards developing a career for themselves. They remain unaware of the stark reality of today's society in which over fifty per cent of mothers with dependent children work, and only five per cent of the country's households consist of two dependent children, a father in employment and an 'economically inactive' mother (**2.4**). Many youngsters leave school poorly equipped to make conscious and informed decisions about their future life styles – their options already limited by the content of their school courses and by their own restricted image of the future. The development of the capacity to care, to develop and sustain good personal relationships and to share domestic responsibilities is equally important in the preparation of boys as it is for girls. Similarly, career development and job satisfaction is just as important for girls as it is for boys. By upholding and promoting these views, schools and individual teachers can be instrumental in influencing the views held in wider society.

Unfortunately such images are not always portrayed by the media or in advertising campaigns. If certain companies were to be believed, women are always perfectly made-up and either preoccupied by washing things whiter than white whilst keeping their hands perfectly soft and manicured, or they recline sensuously awaiting gifts of confectionery from 'he-men' admirers – some reputation to try to live up to! The same people would have us believe that when they aren't in their local pub and/or admiring some shapely female body, men are decorating entire rooms without making a single splash of paint, or mending a car without getting their hands dirty.

Consider the role models which are most common in the lives of our students. After the messages they receive from the media and their observations of their own domestic circumstances, they will also be conscious of the staffing structure within their schools.

- What proportion of the teachers are male?
- What proportion of the staff in positions of responsibility are male?

It is often the case that the message being put to the boys about their career expectations is infinitely more positive and attractive than that put to the girls.

What does the future hold?

One of the messages to emerge from the first EEC Transition to Work Programme (**2.1**) is that preparing young people for working life means preparing them for adaptability and flexibility. Working life in the late twentieth and early twenty-first centuries is unlikely to follow a rigid path, but will probably consist of a number of different stages which might include education; training; family responsibilities; personal relationships; domestic work inside the home; paid work inside the home; paid work outside the home; self-employment; re-training; periods of unemployment; leisure; adult and continuing education; community or voluntary service. Whilst this is not dissimilar to the traditional pattern of women's lives, in the years to come, both men and women will need to adapt to this more varied pattern of working life.

Implications (taken from **2.1**)

- In preparing young people for adult life, skills of home management, budgeting and parenting should be stressed as important skills for all adults.
- Preparation for personal relationships should demonstrate the possibility of different styles of adult relationships and more equal distribution of tasks and responsibilities within the home.
- Preparation for independent adult life means that girls must be prepared for economic independence (via training and employment) and boys must be helped to develop skills of housekeeping and budgeting for personal independence and family responsibility.

We can contribute to this preparation in three ways:

- by considering the influences which youngsters bring with them to the classroom;
- by looking at the effect of society on our views and expectations in the classroom;
- by challenging stereotypes through the curriculum we offer.

Working as individuals or in groups, within our schools and communities, we can make a difference!

SECTION THREE

The teacher influence

Teachers are important because they mediate between pupils and the subject they study. Their expectations are conveyed to boys and girls in many explicit and subtle ways. On them depends the structure for learning in the classroom or laboratory. They choose and present the curricular materials and activities. They endorse or correct their pupils' behaviour and thereby reinforce or challenge established attitudes and assumptions.

J. Harding, 1983 (**3.1**)

To provide girls and boys with equal opportunities does not necessarily mean providing them with identical educational experiences – we must take into account the different experiences and interests which they bring to their lessons (see Section 1). First and foremost our students are individuals with their own assortment of weaknesses and strengths, aptitudes and interests.

Academically, we make assessments of our students' abilities and come up with forecasts about their futures – sometimes we are involved in trying to modify unrealistic aspirations on the part of a youngster, and other times we are trying to arouse more ambition in an able but unassuming student. There is evidence to suggest that teachers' expectations of their students' academic achievements in science vary according to the sex of the youngster concerned (**3.2**), with boys generally being rated higher than girls.

As the result of a survey of secondary teachers' views of the importance of science subjects for pupils, Margaret Spear deduced that:

Surprisingly, science teachers' responses to the question regarding the importance of science qualifications to pupils' future lives, were more sex-differentiated than the replies received from the group of teachers of various subjects.

Another group of science teachers, from the schools around Manchester which were participating in the GIST project, participated in a similar 'attitudes' investigation. The GIST team provided the teachers concerned with a brief profile of a student and asked them:

1 to advise the youngster about what to do about developing a career;
2 to suggest what the person would be doing at the age of 30.

Half the teachers were given the additional information that the student was called Denise, and the other teachers were told that the student was called Denis.

The difference in the responses from the two groups were quite marked and can be attributed to the additional 'complication' of knowing the sex of the youngster. This had the effect of modifying the thoughts of the teachers so that the suggestions they made conformed to 'stereotyped' images of male and female occupations. Frequently this involved the steering of 'Denise' to relatively low-status jobs (that is compared to those suggested for 'Denis') and greater encouragement given to 'Denis' to build on his existing qualifications in order to further his career. The following is an extract from the analysis of the responses as reported by the GIST team:

A factor of being 'interested in people' tended to be **overvalued** *for Denise (for example predicted to be a hotel receptionist, personnel manager or nurse, all jobs directly dealing with people) but* **undervalued** *for Denis, frequently suggested to be a bank manager or 'in commerce' (that is less directly involved with people).*

Predictions about Denise at age 30 often made reference to her family situation, for example 'working part-time because she is married with two children', while Denis's marital/parental status was not mentioned at all, or alternatively referred to as a reason for occupational ambition.

If this sort of sex-stereotyping pervades our perceptions of our students' futures, how does it affect our subject teaching? Are we also making judgements here about the science which is relevant for the boys and that which is relevant for the girls? The teachers involved in the GIST exercise were unaware of the degree to which they had been influenced by preconceptions about 'appropriate' occupations for men and women. *What can we do to avoid the same pitfalls during science lessons?*

It has been argued in this Curriculum Guide and elsewhere that many of the stereotyped patterns of behaviour exhibited by youngsters are the result of them conforming to their personal images of male and female roles. In this respect they are being moulded by the expectations which they sense from the society in which they live. As teachers, we can play a substantial part in encouraging youngsters to be open-minded about their futures.

Implications

- We can make it plain to all our students that we regard all aspects of science as equally applicable to girls and boys.
- We can make explicit that we expect both girls and boys to participate actively within science, with equal chance of success.

As Jan Harding suggests in *Switched Off: The Science Education of Girls* (**3.1**), we should try to construct an atmosphere in the laboratory in which both boys and girls expect each other to participate and succeed.

The disproportionate numbers of girls and boys studying science after the third year (see statistics in the Introduction) is a testimony to the fact that at present girls and boys do not appear to relate equally to specific areas of science. We would argue that in the past, and to a lesser extent, in many classrooms today, science (and in particular physical science) is presented more favourably to the boys. If in conjunction with this, boys are 'sold' science as a career subject more forcefully than girls, then a rift materialises with identifiable 'boys' and 'girls' science emerging.

The remainder of this Section examines and comments upon some aspects of teaching style and classroom management. In doing so, we make some recommendations for strategies which can be successful in creating a more equitable learning environment for all our students.

Resource materials

Certain teaching materials undoubtedly present a biased image of science because of the selection of contexts used and/or the excessive use of men and boys in the illustrations. Barbara Smail conducted a survey of some lower school science texts with enlightening results (**1.5**). For example, her analysis of the illustrations in *Nuffield Combined Science* activity books show an alarming sex-bias with a male:female ratio of 5.6:1.

The applications selected to illustrate scientific principles or phenomena are frequently polarised, being either very domestic kitchen sink examples or from male dominated activities such as soccer, or related to armaments and weaponry. These only serve to widen the rift between the experiences and expectations of female and male students at a time when we are trying to bring them closer together.

A further category of examples is the impersonal one in which the science is illustrated by a situation outside the sphere of experience of the youngster and/or is stated without any person-centred context. (Examples of industrial processes or the building of electrical circuits can be and often are presented in this impersonal way.)

Student–teacher interactions

Educational research (**1.9**) suggests that in mixed classes of approximately equal numbers of boys and girls, the boys usually receive a disproportionate amount of attention from the teacher. Few teachers would consciously divide their attention in such an unbalanced way but the fact remains that it is common practice. The only accurate way to assess the relative proportions of contact time with individual students is to record a lesson (this takes some preparation and is not necessarily easy to organise in practice) or to ask a colleague to observe a lesson and keep a record of the interactions as they occur. (A checklist appears at the end of this Section (Box 4) which you may find useful if you undertake this exercise.)

There are a number of classroom management strategies which we might use intuitively and which appear to work. Take for example, this experience of one head of science. Reflecting on the experience of being observed in the GIST project, he wrote (**1.4**):

> *If no obvious interest in the subject or topic is displayed, the male teaching staff often flatter the girls or are mildly flirtatious towards them, finding that this is often a successful way of encouraging them. In the same circumstances male teachers will probably appeal to the boys' competitive instincts. We accept that treating the sexes differently in this way may well be encouraging them to see their roles in the world of science differently but are reluctant to abandon successful teaching techniques.*

Here the successful teaching technique seems to mean one that makes the lesson happen rather than one which develops in girls a lasting interest in science – and for this reason, the philosophy put forward is incompatible with the objectives of the SSCR.

From the viewpoint of the learner, successful learning is only achieved when the work has been understood and the personal links have been constructed between earlier knowledge, experiences and the new materials.

Much motivation can be derived from the personal satisfaction of achieving understanding. The knowledge that one's efforts have been recognised and appreciated is also a source of motivation. This is equally true of boys and girls, but are they judged according to the same criteria?

Messages from our teaching styles

Some mannerisms are so unconscious that it takes the observation of another member of staff (or the youngsters themselves!) to bring them to our attention. For example, the use of greater 'eye contact' with the girls when talking about domestic electrical appliances or enzymes in washing powder and conversely more 'eye contact' with the boys when discussing an industrial application of a chemical reaction or the

workings of the internal combustion engine. It could be argued that this is a legitimate ploy because it is taking into account the pupils' interests but that is a convolution of the facts – very few thirteen and fourteen year-olds are actually interested in domestic chores or industrial processes *per se*, irrespective of their sex. They are, however, already in the process of constructing their own images of their future roles and it is in this respect that the 'eye contact' is sending messages about 'appropriate' occupations for them in later life with the accompanying 'relevant' science. As we suggested earlier, it is not easy to identify this sort of habit in oneself, and it is best approached with the cooperation of colleagues or even a trusted group of students.

Behavioural patterns

The following comments reported in *The Times Educational Supplement* **(3.3)** highlight a problem already touched upon in Section One.

> *One girl said boys objected to a girl answering questions: 'Well, they put their pens down, you know, time for a break. If she carries on, they fold their arms, lean back on their chairs and, sort of, look deliberately bored'.*
>
> *Another girl commented: 'The teachers don't give you a chance even if you do decide to say something. They're too worried about the boys starting to play up so they don't let you say things properly. You don't get time, so it comes out all wrong. They let the boys work things out and we don't get fidgety. It's not fair, I always feel I have to hurry up'.*

The solution to this situation is obviously a very complex one and basic to the provision of equal opportunities within any classroom. Inevitably, the older the youngsters we are dealing with, the more entrenched they will be in their habits – which makes the issue more difficult to deal with but all the more necessary. As teachers, we must develop strategies which prevent the boys from 'taking over' the laboratory while at the same time encouraging the girls to 'stand up for themselves' and 'give as good as they get' when exposed to this sort of treatment from the boys. But girls who challenge the norm by being verbally active are discouraged to the point of being branded with labels of 'loud', 'aggressive', 'bossy' and 'unfeminine' by adults, including teachers, and also by their peers. Consequently, many teachers hesitate to encourage girls to be more assertive for fear of exposing them to negative sanctions and ridicule.

There is a marked difference between being assertive ('We need that connecting lead for our circuit . . .') and being aggressive ('Give me that lead' – accompanied by a grabbing action . . .). Our view of a desirable classroom environment is one which is free from prejudices, and where good manners and respect for each other dominate the classroom interactions.

Allocating jobs in the classroom

The organisation of such basic classroom interactions as asking questions, giving help, or in the allocation of tasks may be sufficient to convey messages to youngsters about roles. The practice of consistently selecting boys to be the subject of demonstrations and asking a girl to record the results can serve to reinforce the image of the male being the active contributor to shaping experiences and the female as the passive secretary or recorder of the events.

Isolated accounts of incidents such as these may appear trivial and give the impression of oversensitivity to the situation, but youngsters exposed to these sorts of expectations and experiences frequently, over a period of many years, can hardly be blamed for adopting sex-stereotyped behaviour.

Expecting boys to do their share of clerical work or routine maintenance jobs such as tending the collection of plants or preparing bedding for the gerbils is no hardship to them and useful experience in taking responsibility in a nurturing environment. Furthermore, it is not realistic to suggest that the girls are any less capable of jobs such as moving equipment or furniture than the boys, when the corollary to girls assuming a traditionally feminine role is that they do precisely that during a days housework!

Checklists

In order to help you to establish a clear picture of the situation within your own classroom and department, we have provided these checklists (Boxes 3 and 4).

- Do you praise girls for good ideas as well as for neat work?
- Do you praise boys for neat work as well as for good ideas?
- When you pose questions for the class, how do you select the person who answers? Does this advantage the already confident students to the detriment of the more reserved?
- How do you deal with the students' wrong answers and difficulties?
- Have you any special arrangements for dealing with less confident youngsters who are reluctant to admit to not understanding in front of the whole class?
- Is your attitude the same if you hear boys and girls swearing?
- Are boys and girls punished in different ways? If so, what assumptions underlie this?
- Do your wall displays include illustrations of scientists and technologists at work? If so, what is the ratio of male to female?
- Do your written materials include examples of men and women, girls and boys in 'non-traditional' activities?
- How do you react if you hear one of your students making a 'sexist' remark?
- Who does the tidying up jobs at the end of the lessons (or the sorting and clearing up at the end of term)? Is it boys, girls, a mixed group, you, or is it all left for the lab. technician?
- If you want posters made for an open evening, who does the work? Is it girls, boys, you, or do you have a 'contact' in the art department?
- If you want help to move equipment or furniture during a lesson, who do you ask for help – boys, girls, both/either?
- What is the structure of your science department – how many male/female teachers/lab. technicians do you have? Which people hold the positions of responsibility? How is this interpreted by the pupils?
- Does your department have a liaison programme with local industries? Do your pupils get to meet employees? If so, what is the ratio of male to female and what sort of jobs do they do?

Box 3 *What messages are your students receiving from your style of teaching and from your choice of resources?*

B) CLASSROOM OBSERVATION

A quick guide for observing another teacher's classroom

NAMES used by teacher:

GIRL	BOY

QUESTIONS – record the total number of questions asked by the teacher

Who is asked to reply.

GIRL	BOY

Who answers without being asked.

GIRL	BOY

REMARKS Note any gender-related remarks, whether made by pupils or teacher, e.g. 'the girls at the back'

MADE BY	REMARK

Devised by Mary Linington

Box 4 *Checklist for use by an observer to a lesson*

SECTION FOUR

Ways forward for the science department

A curriculum for girls and boys

The previous Sections have focused on the background which students and teachers bring with them into the classroom or laboratory and which would seem to influence the outcomes of their science education. The roots of inequality may arise outside the classroom but they are reinforced within it. If we are to achieve our goal of equal opportunities, a new science curriculum needs to be planned which challenges youngsters' stereotypes and encourages them to fulfil their own potential. Despite the strong influence of society, change through education is possible and the increasing numbers of women in science-related careers is one testimony to this.

Before laying out some directions for change, we shall look first at the existing situation.

Do school subjects have gender labels?

A study of the attitudes of 13 and 14 year-old children to different school subjects suggests that youngsters attach gender labels to them (**4.1**). Youngsters were asked to rate different subjects on a masculine–feminine scale. Woodwork and physics were rated most highly masculine, while English, French, typing and cookery were most highly feminine; history and biology were fairly neutral.

The same study also showed that the youngsters regarded science as being associated with 'things' rather than 'people', and with thinking rather than feeling. Given the youngsters stereotyped attitudes and interests which we have discussed in Section 1 it is hardly surprising that when presented with options at the age of fourteen, their choices reflect their stereotyped images of the subjects concerned. The bar diagram in Fig. 5 shows O level entries in 1984.

Until the age of fourteen, the curriculum of girls and boys has probably been very similar. Science may be taught in primary schools and is commonly part of the core curriculum in years one to three of secondary schools. Home economics and craft, design and technology are no longer just available for individuals of one sex. Yet given the choice, most youngsters follow courses they view as being appropriate to their sex.

Science as part of the core curriculum until sixteen

The 1985 DES policy statement (**4.3**) asserts that:

all pupils should continue to study a broad science programme, well-suited to their abilities and aptitudes, throughout the first five years of secondary education.

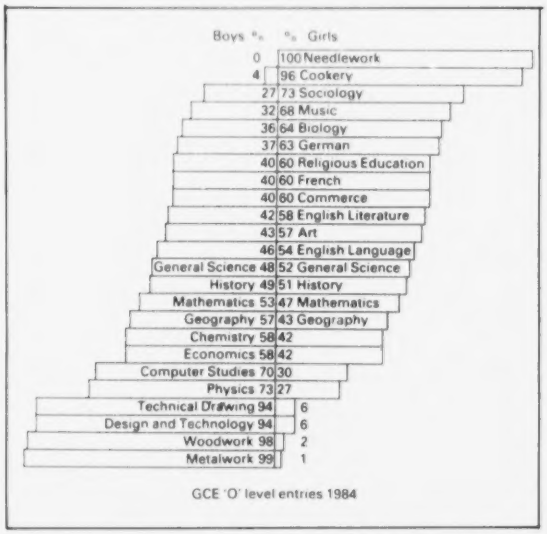


Fig. 5 Sex variations in O level and CSE entries, 1984 (**4.2**)

We would argue that science courses can only be broad and well-suited to their abilities when gender-related disadvantages have been removed from the curriculum.

Most secondary schools already have some science provision for all youngsters within their first three years but some of these existing courses still fall short of the ten principles laid out in the DES policy statement. Many schools are moving towards a 14 – 16 science curriculum which incorporates aspects of physics, chemistry, biology and earth sciences for all youngsters. Indeed, much of the development work in this age range from SSCR groups has been along these lines.

Youngsters will thus keep their options open for the future, they will be assured of access to the science curriculum, and they will not be discriminated against because of their gender . . . *or will they?*

Merely making science compulsory in secondary schools *does not tackle the underlying problem which has been documented in previous sections.*

It is important that we do not confuse the appearance of science for all on the school timetable with the actual provision of meaningful science experiences for all youngsters. The old

saying about taking a horse to water is applicable here, and we cannot afford to regard the introduction of compulsory science as a panacea. At the moment students can vote with their feet and if they do not wish to continue with science, their school option system often gives them the opportunity to drop out of at least some science in years four and five. With the introduction of a balanced science for all policy, many youngsters will be present as conscripts rather than as volunteers in our GCSE classes. If we fail to generate new science courses to meet their needs they may resort to the ploy of 'mental truancy'. Unless we look at the causes of disadvantage and take positive steps to overcome it, the science curriculum of the future will not address the educational needs of all youngsters.

This curriculum will:

- reflect the interests of both girls and boys;
- challenge the existing notion that science is a masculine activity;
- discourage boys from dominating science lessons and encourage girls to view their contributions as having equal value;
- value equally the experiences of both girls and boys;
- compensate youngsters for lack of previous science-related experiences;
- be set in a context to which all youngsters are able to relate.

Box 5 *Features of a curriculum aiming to overcome gender disadvantages*

There are some lessons to be learned from existing courses which have achieved good records of maintaining the interest and motivation of both girls and boys across the science curriculum. Notable in this respect is the Schools Council Integrated Science Project (SCISP). A recent comparison (**4.4**) of the subsequent A level choices of students studying SCISP courses during the period 1980 – 1982 and their non-SCISP equivalents, has indicated an above average entry to A level science courses from the SCISP students. This is a positive indication that the students concerned have enjoyed and valued the science education provided by this integrated course with its emphasis on the processes of science and a wide range of applications and implications. Also encouraging for teachers moving towards balanced science schemes, is the success which SCISP has achieved in attracting students to consider less stereotyped A level courses:

> *Of the SCISP boys, 21.5 per cent chose to do biology either on its own or in combination with chemistry and/or physics. This compares with 9.8 per cent of the non-SCISP boys . . . larger percentages of SCISP girls go on to study physics (38 per cent) and chemistry (54.5 per cent) compared to non-SCISP girls (21.2 per cent and 39.8 per cent respectively)* (**4.4**).

SCISP as such will not be examined after 1987 but some examining groups are providing integrated science syllabuses, and new 'integrated science' texts are now on the market. All the groups are producing 'double subject' syllabuses, which include elements of physics, chemistry, biology, and other sciences, which can be taught as modular or thematic courses. However, in assessing the merits of the various syllabuses on offer, it is important to be aware of the teaching and learning styles inherent in them or dictated by them.

Now we shall go on to examine strategies which have been employed in moving towards a future curriculum for all youngsters. Without doubt, the issue of equal opportunities for our youngsters extends far beyond the science laboratory and ideally should be approached from the perspective of the whole school. However, the primary purpose of this guide is to help science teachers to get their own house in order, and this is why we have entitled this section 'Ways forward for the science department'.

A future curriculum

The activities which we shall describe have been used successfully by the teachers who devised them, and in our opinion they represent examples of movement towards more equitable learning environments. In the limited space available, it is only possible to provide short résumés of the activities and to give an indication of the conditions in which they were used successfully. (Further details of most of our examples can be found in the reports produced by the SSCR groups and listed in the SSCR directory.) (**4.5**).

These examples inevitably represent the tip of the iceberg as far as solutions to the problem are concerned but we offer them as suggestions in the hope that they will encourage other teachers to devise their own strategies and resources. We have grouped them under five subheadings.

1 Looking at ways of assessing the scale of the problem within our own schools and in science departments in particular.
2 Examining the images of science which we are projecting by our present teaching styles and our use of resources. Moving towards a wider, less stereotyped representation of science.
3 Widening the scope of the curriculum to take into account the different interests, backgrounds and learning styles of youngsters.
4 Identifying existing disadvantages for groups of youngsters, and adopting strategies for

overcoming them.

5 Demonstrating to youngsters that experience of scientific processes and concepts is important for their futures.

Looking at ways of assessing the scale of the problem within our own schools and in science departments in particular

There is no single starting point for individuals and departments in this task because of the diversity of levels of awareness which already exists in different schools. However, it is common for teachers to underestimate the scale of the problem before they investigate the factors which are at play within their own teaching environment. This only serves to emphasise how certain behaviour patterns are ingrained in our culture and so are virtually invisible to the casual observer.

The checklist in Section 3 enables teachers to assess what messages students might be receiving from their style of teaching and their choice of resources. Using these or similar questions as prompts is a good way of beginning to see the situation through the eyes of the youngsters. An in-service pack produced by the SSCR (**4.6**) may provide a useful tool for departments to examine their own practice. One of the suggested activities is the use of a video depicting aspects of discrimination in a science lesson which has been produced by an SSCR working group in Kent, in conjunction with Kent Educational Television (**2.2**). Included in the work of the Kent group is a questionnaire for students which is intended to get them to make their own ideas about male and female roles explicit. Such a survey might help in the development of discussions with youngsters to help them to appreciate that their own sex-stereotyped views may limit their choices for the future.

In schools where students can still opt for separate sciences at the age of 14, an indication of youngsters' attitudes to science can be obtained by analysing their choice of science subjects (or conversely their 'dropping' of science subjects). This task was undertaken on a large scale by the Hertfordshire 'Attitudes to Science' group who surveyed option patterns in their LEA with the use of a questionnaire. The group reported that the overall pattern of subject choice shown by the survey in maintained mixed schools in Hertfordshire is close to the national statistics published by HMI and APU in that, overall, they reflect the now familiar sex-linked choices. However, what is interesting about the Hertfordshire study is that there are quite a number of mixed sex schools which do not follow the pattern. *Why can some schools maintain the interest of girls in physical science while others have failed?* The group attempted to write case studies of such schools in order to try to pinpoint some factors which influenced girls' choice of physics at option time. In one co-educational comprehensive school, 54 per cent of fourth-year girls were studying physics, a much higher proportion than in many schools. The head of physics at the school felt that the five most important influences on this choice were:

- linking theory and practical teaching to everyday practical examples;
- doing the maximum amount of practicals and demonstrations;
- minimising abstract and intangible theory;
- encouraging enthusiastic teaching in the lower school;
- using a flexible syllabus to allow for lateral development of the subject according to the interests and abilities of the group.

A similar self-help mechanism can be developed within an individual science department with staff discussing aspects of their own teaching styles and how girls and boys relate to these different approaches. Perhaps in particular, specialist biologists and physicists need to exchange views more regularly in order to widen the appeal of their individual subjects to all youngsters.

Ways forward

- Examining current option choices for sex-bias.
- Identifying and disseminating practice which appears to motivate girls and boys.
- Surveying student attitudes to science.
- Evaluating classroom practice to identify possible sources of discrimination.

Examining the images of science which we are projecting by our present teaching styles and our use of resources. Moving towards a wider, less stereotyped representation of science

Analysis of science textbooks and worksheets (Box 6) provides some idea of the degree of stereotyping which is present in them.

Resource materials which are identified as being inappropriate because of the images they portray might be used as a starting point for discussions with students. During the GEMSAT project, student materials were produced specifically to bring issues relating to gender and stereotyping to the attention of the youngsters (**1.6**):

Six schools attempted to highlight the issue of stereotyping. This was done via questionnaires, fact sheets and worksheets. The Equal Opportunities video 'What are we really made of?' also provided stimulating discussion materials. One school used popular TV programmes, for

example, 'Coronation Street' and "Allo 'Allo' to illustrate the media's reinforcement of common stereotypes regarding the role of women in society.

- How many members of each sex are represented – in the text, and in the illustrations?
- Are women and girls shown in passive roles while boys and men are the active partners?
- How many of the images of men and women challenge traditional stereotypes (for example women carrying out geological surveys or men bathing babies)?
- How many of the images only serve to perpetuate unnecessary stereotypes such as all female nursing staff assisting male doctors?
- When scientific occupations are referred to, are there examples of both male and female scientists and technologists at work?
- Are the applications of science and examples of science in action as likely to appeal to both sexes? That is, do they take into account possible differences in interests and experiences?

Box 6 *Analysis of textbooks and worksheets*

It is also important to bear in mind that there have been many women scientists and that their contributions are not always acknowledged to the same extent as their male counterparts. Barbara Smail's book (**1.5**) includes profiles of some women scientists and references to many others.

Many science text books may not have the problem of sex-stereotyping because they are almost devoid of people! However, we do not think that this is in any way a solution. As we have discussed in Section 1, girls in particular are less interested in science if they perceive it as being about 'things' rather than about 'people'. This tendency is greatest within physical science topics, so it is particularly necessary here to make an effort to present the work in such a way that the human elements are given more prominence. In this way the youngsters are able to relate the information to events and circumstances which are meaningful for them.

'A human approach' is how an Avon group describe their strategy for interesting girls in physical science (**4.8**). They are producing a pack of activities designed to supplement work on the topic of electromagnetism. As well as information on the scientists who worked in the field, there are suggestions for more personalised practical investigations as well as details about how to carry out market research, an aspect of scientific investigation which is very much human-centred.

Another Avon group has produced examples of problem-solving activities for youngsters which set the problems in a human context (**4.7**). Compare the two examples in Fig. 6 – one an activity from the Avon group (**4.7**) and the other a more familiar, impersonal one on the same topic (**4.8**).

Another way in which science can be perceived as being removed from human experience is through the impersonal language which is used for report writing. While not denying the importance of developing such skills, there is also a place for providing opportunities for youngsters to do their

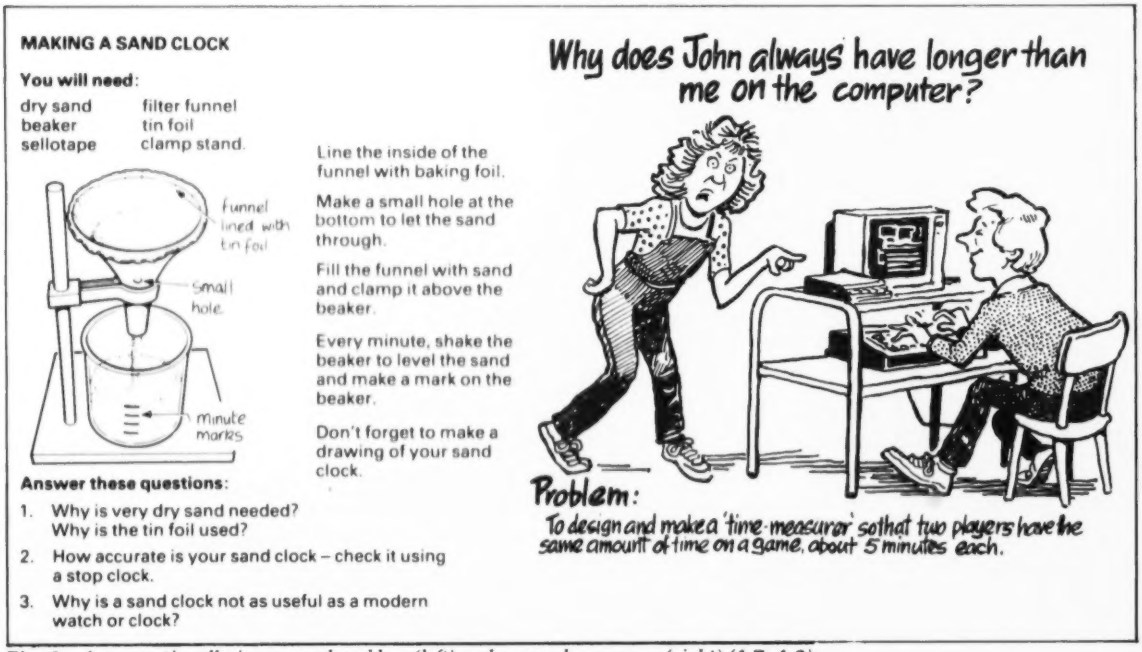

MAKING A SAND CLOCK
You will need:
dry sand
beaker
sellotape
filter funnel
tin foil
clamp stand.
Funnel lined with tin foil
Small hole
Minute marks
Line the inside of the funnel with baking foil.
Make a small hole at the bottom to let the sand through.
Fill the funnel with sand and clamp it above the beaker.
Every minute, shake the beaker to level the sand and make a mark on the beaker.
Don't forget to make a drawing of your sand clock.
Answer these questions:
1. Why is very dry sand needed? Why is the tin foil used?
2. How accurate is your sand clock – check it using a stop clock.
3. Why is a sand clock not as useful as a modern watch or clock?
Why does John always have longer than me on the computer?
Problem:
To design and make a 'time-measurer' so that two players have the same amount of time on a game, about 5 minutes each.

Fig. 6 *A conventionally impersonal problem (left) and a more human one (right)* (**4.7, 4.8**)

own personal writing in science. Rather like the scientists of old, the idea of a science journal is a useful one for jotting down ideas, asking questions and generally 'talking to oneself'. Work from a Wiltshire SSCR group demonstrates the potential of this sort of journal writing, which they call 'Think Books' (**4.9**). In the words of one girl:

> *I think that when you write a journal you can go on and on thinking loads of ideas which just shows how much you do or don't know . . . Journals are useful because you can look back at them but if you keep your thoughts in your head later on you will forget what they are and they could have been useful. You can see where you have gone wrong. Journals are like another science lesson, but private.*

Not only does it enable them to express themselves more freely, but it also helps them sort out their ideas and relate to the science more efficiently than following a prescriptive writing up procedure.

Ways forward

- Surveying resources for gender-bias.
- Involving students in discussion about sex-stereotyping.
- Including materials about the lives of female as well as male scientists.
- Emphasising that science is a human activity which relates to peoples' lives.
- Providing opportunities to use a more personal, expressive language.

Widening the scope of the curriculum to take into account the different interests, backgrounds and learning styles of youngsters

In Section 1 we tried to show where differences between girls and boys might affect how they relate to school science. Since the youngsters arriving at secondary schools already have different interests, experiences, aspirations and learning styles, it behoves us to develop as broad a range of strategies as possible so that the way we present science does not favour one sex rather than the other.

The GEMSAT team reported that the major changes which evolved as a result of their intervention strategies were mostly related to teaching styles rather than to changes in the content of the science curriculum (**1.6**). The teaching materials which were produced employed more active learning strategies, were more visually attractive and enabled youngsters to work at their own pace.

In order to promote more student-centred enquiry work, we recommend that youngsters are encouraged to formulate their own questions and test out their own ideas whenever possible. This has the merit of reducing the level of public interaction with the teacher, and is therefore to the benefit of the less extrovert students. (It has been suggested that girls respond particularly favourably to this style of working.) At the same time, it encourages independence in the youngsters' learning styles, whilst still allowing them to work cooperatively on group tasks.

An SSCR group in Gloucestershire is producing a consumer research exercise for students which is related to the design of a 13 amp plug. For the exercise the youngsters are provided with a selection of plugs of slightly different designs as in Fig. 7.

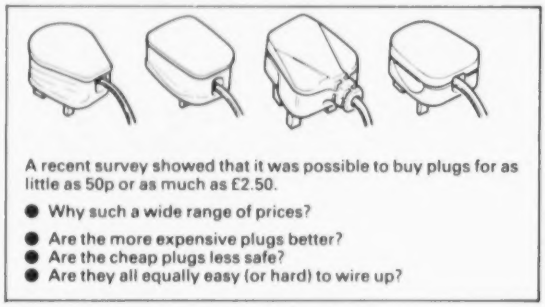

A recent survey showed that it was possible to buy plugs for as little as 50p or as much as £2.50.
Why such a wide range of prices?
Are the more expensive plugs better?
Are the cheap plugs less safe?
Are they all equally easy (or hard) to wire up?

Fig. 7 A consumer research exercise

The student activity was framed by the task being set in the context of a consumer research report for a local radio station.

> *Imagine that you work for a local radio station and the programme planner has asked you to make a two-minute report about the plug survey. What sort of information would be most useful to the listeners?*

A particularly good example of work with both a human context and with a consumer element involves youngsters in the development of a new yoghurt (Sheffield biotechnology group (**4.10**)). The youngsters are involved in an open-ended investigation, combined with an element of role play by taking on the 'jobs' of customer researchers, yoghurt scientists or marketing advisers. In order to provide some structure to the lesson, the Sheffield group has produced student sheets giving the basic facts and background information for each of the roles. In this way, individual youngsters each have responsibilities to carry out work under their own initiatives but they must also feed their findings back to their fellow students who represent the other members of the yoghurt company staff.

The common interest of girls and boys in the science of the human body provides a context for teaching. For example, a scheme of work which relates science principles to the human body was devised by Barbara Smail (**1.5**). Figure 8 shows how biological and physical sciences can be linked in a lower school science course by starting with

the application (the human body and how it works) and moving from there into more abstract concept areas.

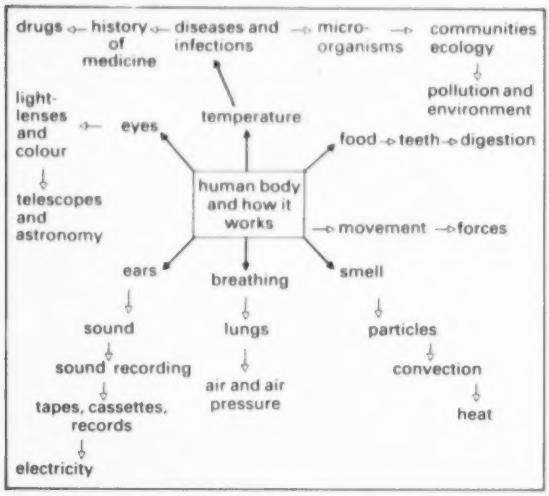


Fig. 8 *Map of a lower school science curriculum based on the human body* **(1.5)**

One SSCR group has developed a cross-curricular approach to science by working on the theme 'communication' **(4.11)**. Again, the starting point is within the realms of experience of the students involved. The introductory activities are about sending messages, and the youngsters are encouraged to explore means of communicating such as body language, gestures and early picture language before moving on to more complex and technological means of communication. As well as the information technology aspects of communication, youngsters are also given opportunities to investigate aids for the disabled – one way of setting science in a 'caring' context.

Many of the examples of the applications of physical science in textbooks relate to traditional 'boys' interests' – for example cars, aeroplanes and guns. While not arguing for the total exclusion of such examples, we ask for a balance to take into account the experiences and interests of young people of both sexes. Therefore we suggest that examples of science in action which stress its caring applications warrant inclusion and are more likely to be of interest to both sexes.

The Newcastle 'medical technology' group, spent time at a local hospital finding out more about these sorts of examples. They are developing teaching suggestions and information about the technology surrounding modern heart and kidney surgery as well as giving youngsters the opportunity to consider the personal implications for the individual patient.

Providing opportunities for youngsters to both 'think' and examine their feelings is another strategy we would recommend. Many of the science questions which they will meet as future citizens will ask them for their opinions – 'Do you agree that artificial colouring should be banned from tinned foods?' 'Should animals be used in research into the effects of cosmetics?' etc. By enabling youngsters to engage in such issues, we encourage them to appreciate the difficulties of making such decisions and give them practice at selecting and sorting information and assembling their arguments. At the same time they are learning more about the influence of their own emotions on their decision-making.

Being exposed to a range of opinions and being given opportunities to analyse the arguments is necessary in the preparation of scientifically literate citizens. One of the exercises from the Sheffield biotechnology group **(4.10)** provides such an opportunity. Students are provided with a range of opinions on the subject of human genetic engineering through background notes about four people with different views on the subject. Several preparatory exercises help them to focus on the opinions and the exercise culminates in a class activity in which students representing the four people with different views are the panel for an activity based on the 'Any Questions?' radio programme.

Until recently, material on the social issues of science has tended to be produced for sixth form work. However, the ASE-sponsored project 'Science and Technology in Society' (SATIS) **(4.12)** has produced many useful student materials which are a most welcome addition to curriculum resources for the 14 – 16 age range.

Ways forward

- Including teaching approaches which enable students to test out their own ideas.
- Relating physical science principles to the human body.
- Providing more examples of the 'caring' applications of science.
- Starting from personal experiences.
- Providing opportunities to discuss and explore opinions which relate to science-related social issues.

Identifying existing disadvantages for groups of youngsters, and adopting strategies for overcoming them

In order to tackle this, we need to find out where the problems lie. In Section 1 we discussed the most recent research findings concerning differences in aptitude, behaviour and experience which is commonly displayed by girls and boys by the time they enter secondary schooling. The identification of specific learning difficulties is dealt with more extensively in the companion guide **Better Science: For young people with special educational needs** so we will confine ourselves to two particular skills which appear to

be most influenced by sex-stereotyping; manipulative skills and social skills.

The development and deployment of manipulative skills in science lessons can be a problem for many young people. As the APU survey shows (see Section 1: *Differences in aptitudes and experience*) girls can be at a particular disadvantage because of their lower levels of certain types of practical experience in early childhood.

One area in which the previous experiences of boys does appear to give them a great deal more confidence and aptitude is in the topic of electricity. At the risk of over-generalising, we suggest that many girls are conscious that boys appear to know what they are doing with the apparatus and are working quickly and confidently, whilst the girls are still wrestling with constructing simple circuits. A worthwhile exercise for both girls and boys, is one in which individuals set up circuits for each other, with one simple fault – it could be a connection missed out or a bulb incorrectly fitted – and once the fault has been identified, the youngsters reverse roles. This has the advantage that the girls are able to develop confidence at constructing circuits and at fault-finding in a cooperative, non-threatening atmosphere, and the boys can carry out the same exercise with perhaps a more competitive edge to the task.

As Section 1 demonstrated, the lack of cooperation of many boys (and indeed of some girls) within science lessons can be a problem which exacerbates the difficulties involved in providing equal opportunities. A possible solution is to move to single-sex teaching groups in an attempt to give the girls a working atmosphere in which they do not feel pressurised or continually overshadowed by the presence of the boys. The GEMSAT report (**1.6**) describes one such initiative which appears to have benefitted the girls in that they appeared to take a more active part in the lessons. While acknowledging that such an approach can be helpful in the short term, it does present certain dangers. It would be possible for two sciences to develop in school, one for boys and a different one for girls, and thus an opportunity to gain from different approaches is lost. At the same time, girls and boys will eventually have to work alongside each other so perhaps they ought to be developing the necessary social skills as soon as possible. While single-sex groupings may be used to develop the confidence and assertiveness of the girls, we feel that this is no substitute for actively challenging classroom behaviour which discriminates against either sex.

If interpersonal skills are to be seen as being valued, then they must be a key component of our objectives for science education. Many SSCR groups have worked on science profiles which incorporate such social skills. The Avon 'Half Our Children' group created a skills framework which they argue ought to be basic to science courses. Their categories are:

- Manipulative skills
- Communication skills
- Experimental skills
- Study skills
- Observational skills
- Measurement skills
- Social skills

Adopting social skills in such a list requires us to provide all youngsters with opportunities to use and develop such skills. We have included the following examples in order to give a flavour of the type of activities which we feel are particularly pertinent to this issue.

The Devon 'Science Skills' group has produced two teacher manuals which document strategies for teaching the skills of listening and of working in small groups (**4.13**). This group suggests that specific emphasis on teaching these skills will encourage youngsters to work cooperatively with each other and we endorse this view.

Another example of an activity which requires youngsters to work to high levels of cooperation is the use of role playing exercises – for example, the simulation of a public inquiry being trialled by one Avon group as part of their work on 'electromagnestism'. The students' task is to sift through the evidence relating health problems to the siting of high voltage power cables. They then discuss the issues by playing the parts of residents, electricity board officials, doctors and environmental groups.

Ways forward

- Finding out about individual difficulties with regard to skill development.
- Providing opportunities to practise skills in a non-threatening environment.
- Developing teaching approaches which aim to develop social skills.

Demonstrating to youngsters that experience of scientific processes and concepts is important for their future

In an effort to develop more positive attitudes to science and what it has to offer for everyone's future, one Hertfordshire SSCR group produced their own publication aimed at students and their parents involved with option choices. It is a lively booklet (see Fig. 9) called *Science for You?* (**4.14**), which:

- looks at the role of science in society;
- examines ways that science education can help personal development;
- focuses on the careers for which a background in science is necessary or useful;

- has photographs and statements from girls who have a variety of science-based careers, for example in hairdressing and engineering.

Bringing people who use science in their work into school focuses on the potential of science-based careers and can be used as another way to challenge existing stereotypes. The GIST project organised visits into schools of women working in science and engineering. The GEMSAT project organised a 'Challenge to industry' conference which enabled girls to find out more about the work and lives of women in industry and commerce.

In conjunction with the local library and careers service, a Wiltshire group developed a travelling display which looks at the life of one young woman apprentice. Again, this is an attempt to challenge existing stereotypes and encourage more girls to think of careers they would not normally consider. However, we suggest that in the interests of equal opportunities for the boys as well, there ought also to be opportunities to meet both men and women who have taken up non-traditional careers. For example, lessons about human reproduction and childcare could involve a father and child, medical topics could be illustrated by a visiting male nurse, and a woman who has served a craft apprenticeship could be invited to talk about her work.

It isn't just the students themselves who need to be better informed. Parents too need to be updated. In many schools, choosing options in the third year is still a crucial time and both the GEMSAT and GIST projects were active in promoting the message of equal opportunities at careers conventions and 'option days'. Again this is a time when the attitudes of parents, students (and teachers) can be challenged. Opportunities can be provided for them to find out more about men and women who have been able to step outside their traditional roles.

Access to up-to-date careers information with an emphasis on equal opportunities is readily available from the Equal Opportunities Commission. They produce large numbers of information leaflets and videos for youngsters making careers choices, as do many of the professional engineering and scientific bodies. In short, there are plenty of resources accessible to teachers and youngsters. However, it should be noted that much of the thrust in the industrially sponsored materials is directed towards attracting the most able academic youngsters into industry.

Alternative industrial links are being forged daily under the auspices of a variety of new initiatives, not least of which is the TVEI scheme. As contacts are established and industrial liaison is developed, it will be necessary to maintain close links with such initiatives for our mutual benefit.

Ways forward

- Demonstrating the importance of science education for everyone.
- Demonstrating the importance of science qualifications for a wide range of careers.
- Challenging stereotyped views about career options.

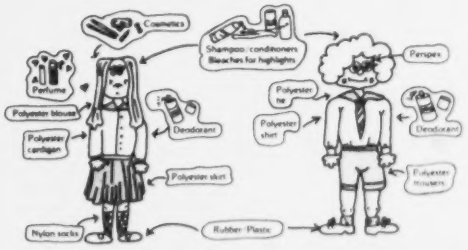
The tip of the iceberg

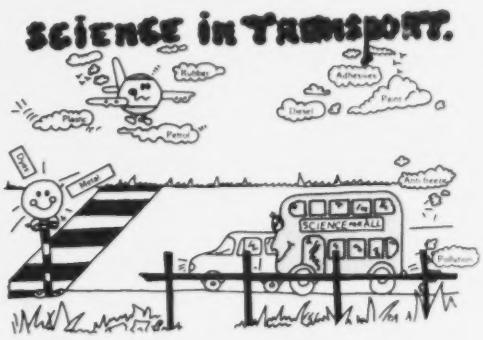
The strategies put forward in this section are only beginnings as the research reports from GIST and GEMSAT have revealed. Much of this report has dealt with attitudes shaped by a society which still holds onto traditional views about the roles of the two sexes. In this respect, trying to influence attitudes in secondary schools is perhaps a last resort. However, equal opportunities awareness is growing in all sectors of education, and publishers of educational books are much more sensitive to the images of men and women they present. The case studies of schools with good practice and other recent research reports encourage us to believe that schooling can make a difference to student achievements and attitudes. Only by all working together in the direction of equal opportunities will real change be effected. To that end we welcome the LEA policies on the issue, although in the end it is the classroom teacher who has to develop the necessary strategies. We have here highlighted work that is currently underway and we would encourage readers to try out some of the ideas we have proposed.

Most of the suggestions might be considered to be about good educational practice rather than to have anything specifically to do with gender. As we said at the start, listening to the largest group of critics of science education, that is the girls, we believe that it will improve for the benefit of all. However, given the many changes which are being proposed to improve science education, it is worth considering the possible consequences for girls who are currently most disadvantaged. If the new science curriculum means that they remain disadvantaged in comparison with the boys, then we will not have achieved our purpose of providing equal opportunities.

Science is all about you!

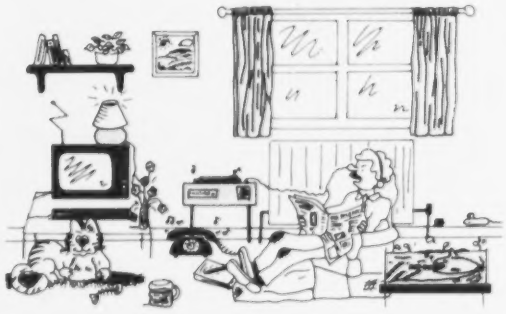
You can even find the products of science on you!





Science at home

Look around yourself at home and think about all the things that have been invented with the help of **Scientists, Technologists** and **Engineers.**



There are the obvious things like the TV, the stereo and the telephone, but who invented and made the nylon and other synthetic fibres which might be in your carpet, curtains and chair covers? Who produces the dyes and paints that make our rooms so colourful? You guessed it! All of these are the work of **Scientists, Technologists** and **Engineers.**

Think of all the things at home that are made of plastic, from small things like light switches to perhaps even the window frames. Plastic does not grow on trees! It's made by ..... (guess who?)

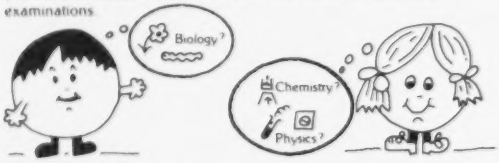
The modern world needs young people with science skills.

Young people who:

are inquisitive
have lots of enthusiasm
can communicate in lots of ways
are good with their hands
have opinions about the world
have lots of energy
are adaptable
can work as part of a team
have new ideas
can interpret data

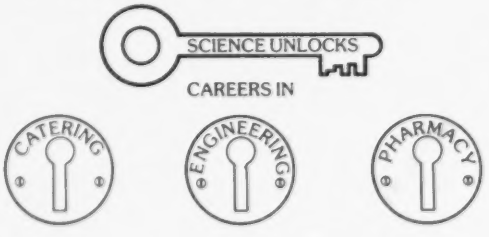
Science for YOUR future.

Many young people do not know what job they want to do when they leave school. That is a big decision which often takes a long time and a lot of information and thought. However, in the 3rd year at school you are often asked to decide which subjects to study for external examinations.



With science subjects you will have a bigger choice when you do decide what job to do. More employment opportunities are open to you especially with the **Physical Sciences**, that is **Physics** and **Chemistry.**

Science is a **key** to open more doors for your **future.**



and **many** more

Fig. 9 Extracts from the Hertfordshire SSCR publication 'Science for You?' **(4.14)**

SECTION FIVE

Conclusions

Science education for all students is changing with:

- the introduction of GCSE and profiled assessment;
- a greater emphasis on the processes of science;
- a greater emphasis on problem-solving;
- science and technology being viewed across the whole curriculum;
- pre-vocational elements being introduced into 14 – 18 curricula.

What are the implications as far as equal opportunities go?

1 The introduction of GCSE and profiled assessment

With more subjective forms of assessment there is the potential for recording a wider range of qualities possessed by an individual. Arguably this could prove advantageous to the girls who may show better linguistic and social skills. However, the qualities which constitute a 'good' student are defined by the assessor. How do our own attitudes affect our assessments? Research in this country (**3.2**) suggests that when making assessments, many science teachers are affected by the gender of the students, often giving lower marks to the work they believe to have come from a girl. This gender bias in assessing performance is also suggested by work in mathematics (**5.1**) where the learning behaviour displayed by many girls was valued less than that displayed by boys of similar ability.

2 A greater emphasis on the processes of science

Merely emphasising the processes of science is not going to make science more attractive to girls as the recommendations in Section 4 suggest. However, if the content of science becomes less important, then we must ensure that both sexes are not disadvantaged because of their lack of early childhood experiences which aid development of some key science concepts. For girls, this might well mean lack of knowledge and understanding in certain areas which disadvantage them in the job market. For example, lack of experience in mechanics or electronics could put up barriers to a future in engineering.

3 A greater emphasis on problem-solving

Such teaching strategies encourage teachers to adopt an open-ended approach. Thus unlike the old 'experiments to prove' there isn't (usually) only one right answer, but several solutions which fit the brief. However, the model for problem-solving which is generally accepted involves students in evaluation. 'Evaluation' by definition springs from 'values'. What are the criteria which youngsters in a class will use to evaluate their solution? Is a solution more valuable because it is cheaper to make, better to look at, or because it results in less environmental upheaval? There are no right answers to such questions but, as teachers, will our 'values' dominate the evaluation process?

4 Science and technology being viewed across the whole curriculum

An examination of the kinds of activities which feature as part of technology courses at present reveals that they rely on knowledge from the physical sciences particularly. Many of the examples are of high technology and relate more closely to the experience of boys than girls, for example, electronics and bridge construction. While not denying the importance of such activities, we would argue for balance. Girls' experiences are as relevant to technological education as boys. The new approaches to home economics are technological in nature and themselves draw heavily on a base of scientific knowledge. Thus a wider definition of technology education is required if we are to redress the balance.

5 Pre-vocational elements being introduced into 14–18 curricula

These elements tend to be work-related and thus science is in danger of playing only an instrumental role in preparing youngsters for future paid employment. We would emphasise the enrichment role of science which contributes to a youngster's 'education for life'. Thus home- and leisure-oriented elements have as important a place in pre-vocational education as those orientated to paid employment.

As new approaches to teaching science emerge, we must be constantly aware of these and other tensions with respect to ensuring equality of opportunity for all youngsters.

In conclusion, we suggest that progress towards a better science education for all requires us to take on board the 'female' as well as the 'male' experience. Since the number of male science teachers far outnumbers females particularly in the physical sciences, this is perhaps a tall order. However, we suggest that the discrepancy in these numbers is partly because of our current failure to acknowledge the important contribution of female experience in science education.

Action by teachers, schools and local education authorities can make a difference!

Further reading

Gender and schooling

Deem, R. (ed.) *Schooling for Women's Work*, Routledge and Kegan Paul

Delamont, S. *Sex Roles and the School*, Methuen, 1980

Kant, L. and Brown, M. *Jobs for the Girls*, Schools Council Pamphlet 22, 1983

Millman, V. and Weiner, G. *Sex Differentiation in Schooling: Is there really a problem?*, Longmans, 1985

Sharpe, S. *Just Like a Girl*, Penguin, 1982

Spender, D. and Sarah, E. *Learning to Lose: Sexism and education*, The Women's Press, 1980

Whyld, J. (ed.) *Sexism in the Secondary Curriculum*, Harper and Rowe, 1983

Whyte, J. *et al* (ed.) *Girl-friendly Schooling*, Methuen, 1985

Gender and science

Alic, M. *Hypatia's Heritage: A history of women in science from antiquity to the late nineteenth century*, The Women's Press, 1986

Brighton Women and Science Group (L. Birke, W. Falfner, S. Best, D. Janson Smith, K. Oldfield) *Alice through the Microscope*, Virago, 1980

GASAT 3 Papers for the Third International Conference on Girls and Science and Technology, Chelsea College, University of London, April 1985

Fox-Keller, E. *Reflections on Gender and Science*, Yale University Press, 1985

Easlea, B. *Science and Sexual Oppression*, Weidenfield and Nicholson, 1981

Kelly, A. (Ed.) *The Missing Half*, Manchester University Press, 1981

Whyte, J. *Girls into Science and Technology*, Routledge and Kegan Paul, 1986

Whyte, J. *Gender, Science and Technology: Inservice handbook*, Longman Resources Unit, York, 1985

If you want to use this Guide for in-service work you might find the *Equal Opportunities Workshop Pack* useful (available from the SSCR).

Careers information

Available from The Equal Opportunities Commission, Overseas House, Quay Street, Manchester M3 3HN. This includes material produced by the EOC as well as lists of resources produced by other organisations.

References

The SSCR publications referred to in the text under the series titles **Better Science** are not listed here.

0.1 Assessment of Performance Unit *Science survey reports at age 15* 1981 and 1984

0.2 *Science Education 11–16: Proposals for action and consultation*, SSCR, 1983

0.3 Johnson, S. and Murphy, P. *Girls and Physics* APU Occasional Paper 4 HMSO, 1986

1.1 Dynan, M.B. *et al, Physical science evaluation 1978* Cooperative Research Series No. 3, Education Dept. of Western Australia, Perth 1980; and Taylor, S. 'Schooling and social reproduction', *Australian Journal of Education* 1982

1.2 Byrne, E. *Equality of Education and Training for Girls (10–18)*, Commission of the European Communities, 1979

1.3 Beswick, D. 'The effect of sex differences on students' choices', in Anderson, D et al (eds) *Regional colleges: A study of non-metropolitan colleges of advanced education*, Report to the Commission of Advanced Education, Education Research Unit, Australian National University, Canberra 1975; and Dynan, M.B. *et al*, (in ref **1.1**), 1978

1.4 Girls Into Science and Technology (GIST) *Final Report*, 1981 (Available from Dept of Sociology, University of Manchester)

1.5 Smail, B. *Girl-friendly Science: Avoiding sex-bias in the curriculum*, Longman Resources Unit, York, 1984

1.6 Morton, S. and Price, J. *Time for change*, GEMSAT report, Nottinghamshire County Council, 1986

1.7 Whyte, J. 'Observing sex stereotypes and interactions in the school lab. and workshop' *Educational Review*, 36, pp. 75–86, 1984

1.8 Kelly, A. 'The construction of masculine science' *The British Journal of the Sociology of Science* Vol 6, No. 2, 1985

1.9 Spender, D. *Invisible Women* Writers and Readers Publishing Cooperative, 1982

1.10 *Aspects of secondary education in England*, A survey by HM Inspectors of Schools, HMSO, 1979

1.11 Eggleston, J. Galton, M. Jones, M. *Processes and Products of Science Teaching*, Schools Council Research Studies, Macmillan Education, 1976

1.12 *ILEA Equal Opportunities for Science Departments Pack* ILEA, 1985

1.13 Butler, J. (ed) 'Retention of girls in science: case studies of secondary teachers' from *Women in Science: a report from the field* Falmer Press, 1985

2.1 European Community Action Programme, *Transition of young people from education to adult and working life* (Working Paper). Action Handbook: *How to implement gender equality* Doc. 05WD85EN, Brussels, November 1985 (Programme Information Office, 1FAPLAN, Bruxelles)

2.2 Munson, P. *et al, Girls into physical science*, Kent Educational Television centre, Kent County Council, 1987

2.3 Equal Opportunities Commission *An equal start . . . guidelines for those working with the under-fives*, Manchester

2.4 Equal Opportunities Commission *The Fact About Women Is*, EOC, Manchester, 1982

3.1 Harding, J. *Switched Off – the Science Education of Girls*, Longman Resources Unit, York, 1983

3.2 Spear, M. *Teachers views about the importance of science to boys and girls*, contribution to the GASAT conference, Chelsea College, 1985

3.3 *The Times Educational Supplement*, 7 June 1985

3.4 Stanworth, M. *Gender and Schooling: A study of sexual divisions in the classroom*, Women's Research and Resources Centre, London 1981

3.5 *Implementing the ILEA's Anti-Sexist Policy: A guide for schools*, ILEA, 1985

4.1 Weinreich-Haste M. in *The Missing Half* Ed. Alison Kelly, Manchester University Press, 1981

4.2 DES Statistics, 1984

4.3 DES *Science 5–16: A statement of policy*, HMSO, 1985

4.4 Fairbrother, R.W. and Skinner, R. 'Integrated vs separate sciencies', *Times Educational Supplement*, 18 April 1986

4.5 *Better science: A Directory of Resources*, ASE/ Heinemann, 1987

4.6 *Equal Opportunities Workshop Pack*, SSCR, (in press)

4.7 Sage, J. *et al, Problem Solving in Science 11–13* Resources for Learning Development Unit, Bristol, 1986

4.8 Gunter, J. *Time and Clocks*, Resources for Learning Development Unit, Bristol, 1976

4.9 Bridewell, A. *et al, Science Think Books: An introduction to their use in science lessons* Wiltshire Education Authority, 1986

4.10 Ingleby, D. Winspear, A. *et al, Biotech*, ASE, Hatfield, 1987

4.11 Metcalf, D. *et al, Communication Links across the curriculum*: Hampshire Education Authority, 1987

4.12 *SATIS* materials, ASE, Hatfield, 1986

4.13 South Devon Group *A Skills Approach to the Teaching of Science in the Lower School – Listening* Devon Education Authority, 1986 (An additional title on small group skills to be published later)

4.14 Miflin, H. *et al, Science for You?* Hertfordshire Education Authority, and SSCR, 1986

5.1 Walden, R. and Walkerdine, V. *Girls and Mathematics: From primary to secondary schooling* Bedford Way Papers, University of London Institute of Education, 1985

The Secondary Science Curriculum Review (SSCR) was set up in 1981 to stimulate, through working groups of practising teachers, the development of science studies which would help to provide an appropriate science education for *all* young people growing up in a scientific and technological society — whatever their abilities or career intentions. Its concern was not only with the science curriculum — its contents, purposes, teaching methods and resources — but also with the role of science in general education and within the whole school.

The **Better Science: Curriculum Guides** are based on the combined experience of the Review's Central Team and the working groups. Each Guide deals with a different but significant area of concern. Together they aim to assist teachers both in devising a broader and more balanced approach to science studies and in enhancing their professional development. The intention throughout is not necessarily to provide answers but rather to provoke and encourage teachers' thinking about the various topics addressed.

This Guide, **Better Science: For both girls and boys,**

- considers the growing concern in recent years about the under-representation of girls in physical sciences;
- summarises some of the main findings of recent research projects, which also have implications for the science education of boys;
- sets out an agenda for change;
- provides some practical suggestions to help teachers address the problem for themselves.

ISBN 0 435 54821 2

Also available:

Better Science: A Directory of Resources contains details of a broad range of materials produced by local working groups and the Review's Central Team. It includes descriptive and evaluative statements on each piece of material listed.

Better Science: Making it happen summarises, for a wide audience, the thinking of the Review and provides a guide to implementing balanced science for all pupils.

Heinemann Educational Books/Association for Science Education for the School Curriculum Development Committee

Better Science: Key proposals 1
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Better Science: Approaches to teaching and learning 4
Better Science: How to plan and manage the curriculum 5
Better Science: **For both girls and boys** 6
Better Science: Working for a multicultural society 7
Better Science: For young people with special educational needs 8
Better Science: Health and science education 9
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